Combined Cycle Power Plants
IMIA WGP91(15)
Presentation by:
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CEERISK Consulting Limited
Agenda

• Meet the team
• Methodology
• Technical Review
• Underwriting Considerations
• Operational Considerations
• Claims examples
• Recommendations
## The Team

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Company</th>
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<td>VHV Allgemeine</td>
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<td>Technical Director</td>
<td>Charles Taylor Adjusting</td>
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Methodology

• Research
  • Google
  • Industry publications
  • Periodicals

• Interviews
  • Utility operators
  • Underwriters
  • Risk managers

• Discussions

• Documentation
Scope

Covered
• Technical description of components
• Principles of operation
• Analysis of risk factors
• Underwriters considerations
• Clients’ perspective

Excluded
• Engineering design principles
• Performance review
• Boiler design
• Network and grid connections
• Risk severity and frequency analysis
• Specific loss investigations
Critical Components
Combustion Turbine

- IMIA WGP 001 (1993) Development of Industrial Gas Turbines
- IMIA WGP 013 (00) Large Gas Turbines
- IMIA WGP 064 (09)
Risk Concerns - Combustion Turbines

Ageing equipment

• Consequences
  • Changes in duty cycle from base load to peaking
  • Lower capacity factor and lower revenue
  • Control system obsolescence
  • Excessive turning gear time and blade rock wear
  • Improper layup during extended periods of down time
  • Combustion turbine inlet and exhaust duct deterioration
### Risk Concerns - Combustion Turbines

#### Revolutionary Design

<table>
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<tr>
<th>Year</th>
<th>Model</th>
<th>Details</th>
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<tr>
<td>1992</td>
<td>SGT5-2000E</td>
<td>V94.2</td>
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<td></td>
<td>CCPP Killingholme</td>
<td>2 x 450 MW</td>
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<tr>
<td>2001</td>
<td>SGT5-4000F</td>
<td>V94.3A</td>
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<td></td>
<td>CCPP Mainz-Wiesbaden</td>
<td>&gt; 400 MW</td>
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<td>-2010 (F1)</td>
<td>SGT5-8000H</td>
<td>new platform</td>
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<td></td>
<td>CCPP Irsching 4</td>
<td>&gt; 530 MW</td>
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<td>-2013 (F2)</td>
<td>H-class</td>
<td>evolution</td>
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<td>Next technology target?</td>
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<td>-2013 (F3)</td>
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<td>540°C</td>
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<tr>
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<td>Next technology target?</td>
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Losses – Combustion Turbines

- Compressor high cycle fatigue air foil cracking
- Loss of lube oil supply during operation
- Oxidation and low cycle thermal fatigue cracking
Steam Turbines

VIEW OF THE INTERNALS OF A TYPICAL POWER STATION STEAM TURBINE
Losses – Steam Turbines

• **Phase Transition Zone** is where the steam is condensing into a mixture of steam and moisture droplets.
  • The moisture droplets travelling at high velocity can cause moisture erosion on the low pressure turbine blades and vanes.
  • If left undetected the moisture erosion on the blade and vane air foils can progress to the point that the erosion pits form a stress concentration and crack initiation site.
Heat Recovery Steam Generation System - HRSG

Combined Cycle Utility HRSG

GAS FLOW

H.P. Steam Outlet

Dust Burner

Distribution Grid

L.P. Superheater Outlet

L.P. Superheater

L.P. Evaporator

L.P. Economizer

H.P. Evaporator

H.P. Economizer

H.P. Superheater

H.P. Vent Silencer

H.P. Vent Silencer

L.P. Steam Drum w/ Integral Deaerator

L.P. Steam Drum

Stack

C.O. Catalyst

Injection Grid

S.C.R.
Heat Recovery Steam Generation System - HRSG
Underwriters Perspective and Challenges
Surveys
Tools for underwriters

• Combined cycle power plants (CCPP) are highly engineered risks
  • An engineering risk assessment survey of the location should be requested on
    • 100% of all new submissions
    • 100% of updated renewal information
    • Whenever there is prototypical equipment
    • High Nat Cat exposure,
    • Changes in values,
    • Unfamiliar processes or occupancies,
    • Abnormal loss history frequency or severity.
Types of Surveys

1. **Property survey** which focuses on the fire and natural catastrophe exposures:
   - Natural catastrophe review for earthquake, volcano, tsunami, tropical cyclone, extra-tropical storm, hail, tornado, lightning, flood, storm surge, coastal flooding and the corresponding fixed protection for Nat Cat perils

2. **Machinery breakdown survey** which focuses on the equipment, operations, and maintenance exposures:
   - Equipment condition, protective systems, modifications and upgrades, operational history (hours, starts, and trips), maintenance programs, and personnel O&M training and procedures.

3. **All-risk survey** which is a combination of the property and machinery breakdown survey.
Development of loss event scenarios

• One of the most important element of this evaluation is estimation of
  • MFL - maximum foreseeable loss (some insurers use the term (MPL)
  • MPL - Maximum Possible Loss,
  • EML - Estimated Maximum Loss,
  • PML - Probable Maximum Loss

• Examples of a combined cycle power plant MFL is the catastrophic overspeed and destruction of a combustion turbine and generator, a steam turbine and generator, a HRSG internal explosion, or a severe flood event.
Underwriting Different Phases of the CCPP

Evaluating CCPP Projects

• Underwriters should pay special attention to the following highlights:
  • Power capacity of steam and gas turbines;
  • Turbine, generator and HRSG location within the power unit;
  • Period of major equipment brand marks / models trouble-free operation;
  • GT first firing date;
  • Dates of trial run;
  • Initial operations period, i.e. time between end of trial run and documental commissioning;
  • Defects liability period.
Underwriting Different Phases of the CCPP

CCPP Project Phases

• Early Works Phase
  • Quite simple coverage is required. Usually the coverage of works within this period is based on Munich Re Construction All Risks (MRe CAR) wording with minimal number of extensions.

• Construction Phase
  • The most significant perils are connected with soil conditions, failures of design and possible violation of fire safety regulations.
Underwriting Different Phases of the CCPP

CCPP Project Phases

• Erection Phase
  • Typically covered by (EAR) wording

• Hot Testing
  • Very high risk exposure due to the following reasons:
    • Combustible material are inside the equipment;
    • Machinery is being put under load and it may be damaged

• Trial Run
  • Final stage of hot testing when machinery goes through the peak load

• Initial Operation
  • Starts when trial run is finished
    • It is necessary to get all necessary approvals of the technical authorities and to sign commissioning documents between principal, contractor and the above mentioned authorities.
Trial Run v. Initial Operations
Which is riskier?

**Trial Run**
- Prior to trial run phase a project achieves its full contract value:
  - All facilities are built and all machinery is assembled.
  - Meanwhile machinery has not been commissioned at its full capacity.
    - It is probable that some design or assembly defects appear when machinery is exposed to maximum possible loading.

**Initial Operations**
- When a trial run is finished, testing and commissioning teams leave a construction site.
  - Power unit is being maintained by principal’s operational staff, i.e. by people who are not so aware of emergency situations which may happen to newly assembled equipment as testing and commissioning team.
  - That is why there is a probability of emergency situation occurrence which will not be prevented by operational staff and which will lead to substantial collapse.
Underwriting Special Considerations

Location

• Wind Damage
  • HRSG stacks, Evaporative cooling towers, switchyards

• Flood Damage
  • Critical controls, protective devices, major equipment elevations

• Contamination, fouling and corrosion
  • Coastlines, deserts, oil refineries, chemical plants

• Temperature extremes
  • Additional cooling

• Political and security
  • Supply chain of equipment
  • Safety and security
Operational Concerns

Client’s Perspective

• New design pushing GT boundaries
• New design of LSB
• Integration of DCS
• Risk surveys focus on fire instead of failure
• Lack of plant testing
• Depletion of corporate and industry memory
Conclusions

Things to learn ...

• CCPP’s are the most efficient method of adding electrical capacity to areas with an abundance of natural gas, due to:
  • Low capital cost
  • Shorter construction time
  • Low fuel cost
  • Lower emissions
  • High efficiency and high power density

• The main pieces of capital equipment, that in the event of a loss can exceed the policy deductible, are
  • Combustion turbine,
  • Steam turbine,
  • Generator,
  • HRSG,
  • Generator Step Up (GSU) transformer
  • Cooling system
Recommendations
Things to remember ...

• Detailed risk surveys
  • Property survey
  • Machinery breakdown survey
  • All-risk survey

• A survey should be requested whenever there is prototypical equipment, high Nat Cat exposure, changes in values, unfamiliar processes or occupancies, or abnormal loss history frequency or severity

• Critical issues for underwriters to consider:
  • Location...location...location...
    • Environmental conditions
    • Political & security risks
  • Age of equipment
  • Design (revolutionary v. evolutionary)
  • Project phase
  • Corporate and industry memory
Thank you for your attention